



APPROACHES FOR EVALUATING THE PROPOSED 3PS COD CONSERVATION PLAN AND REBUILDING STRATEGY (CPRS)

Context

International agreements such as the United Nations Fish Stocks Agreement (UNFSA) and the Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries, as well as DFO's Precautionary Approach Framework, call for the rebuilding of depleted fish stocks through application of the precautionary approach. In line with this, continued rebuilding and growth of the 3Ps Atlantic Cod stock is desired to ensure its long-term sustainability and to promote associated economic opportunities.

DFO NL Region, through a Working Group involving DFO Science, DFO Fisheries Management, DFO Policy and Economics, DFO Species at Risk, the Provincial Department of Fisheries and Aquaculture, members of the fishing industry, FFAW, and other non-government Organizations, have developed a draft Conservation Plan and Rebuilding Strategy (CPRS) for the 3Ps stock of Atlantic Cod. This working group identified a need to determine if the draft plan can be evaluated quantitatively. A Science Special Response Process meeting was chosen as the avenue to address this given the short timeline to coordinate such a meeting.

Specific scientific questions were identified to guide the effort to identify approaches for evaluating the proposed 3Ps cod conservation plan and rebuilding strategy (CPRS): 1) *Is the proposed Conservation Plan and Rebuilding Strategy (CPRS) for 3Ps cod described in a form that would allow quantitative evaluation through simulation. If not, what modifications would be required to the CPRS?* 2) *Is the existing stock assessment method (SURBA) for 3Ps cod amenable to quantitative evaluation of the CPRS through simulation? If not, could SURBA be modified to allow such an evaluation or could suitable alternative approaches be developed and applied to carry out such an evaluation?* 3) *Where quantitative evaluation is feasible, are the desirable management objectives of the CPRS known and can they be transformed into measurable performance statistics for simulation testing?*

The Science response did not evaluate the ability of the CPRS to meet the management objectives, rather it determined if the CPRS could be quantitatively evaluated through simulation. It was concluded that the CPRS could not be quantitatively evaluated in its present form, but that modifications might be possible that would allow such evaluation. The present assessment model is not directly amenable to quantitative evaluation of the CPRS through simulation as the model cannot be used to evaluate the specific impacts of catch levels. There are assessment models approaches that could be used to evaluate the impacts of catch levels. However these would need to be developed for the 3Ps stock of Atlantic cod and peer reviewed in an assessment framework process. The management objectives also have not been stated in a way that can be measured.

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Approaches for Evaluating the Proposed 3Ps Cod Conservation Plan and Rebuilding Strategy (CPRS).

Background

Atlantic Cod are distributed from Greenland to Cape Hatteras in the Northwest Atlantic and are managed as 12 stocks. The 3Ps stock off southern Newfoundland extends from Cape St. Mary's to just west of Burgeo Bank, and over St. Pierre Bank and most of Green Bank. The French islands of St. Pierre and Miquelon are within the 3Ps stock area; hence this resource is managed bilaterally with France.

Catches from this stock have supported an inshore fixed gear fishery for centuries and are of vital importance to the area. Fish are caught offshore by mobile and fixed gear. Spanish and other non-Canadian fleets heavily exploited the stock in the 1960s and early 1970s and French catches increased in the offshore throughout the 1980s. A moratorium on fishing initiated in August 1993 ended in 1997 with a quota set at 10,000 t. Over the past decade, total catches have ranged between 8,000 - 15,000 t.

Information available to evaluate stock status of 3Ps Atlantic Cod consists of commercial landings (1959-) and log-book data (1997-) in conjunction with information from Canadian research vessel (RV) trawl surveys (1972-), sentinel surveys (1995-), and a telephone survey, when available, of Canadian fish harvesters pertaining to the recent fishery. The landings data were not accepted as reliable in the last assessment of this stock. Exploitation (harvest) rates are estimated from tagging experiments in Placentia Bay. A survey based cohort model (SURBA) has been used for recent assessments of this stock. This model does not incorporate catch at age data derived from the landings data.

The basis for a limit reference point (LRP) for this stock is Brecovery, defined as the lowest observed SSB from which there has been a sustained recovery. The 1994 value of SSB has been identified as the limit reference level for this stock. SSB decreased over the 2004-09 period and was estimated to be below the LRP during 2008 and 2009. The spawning stock biomass (SSB) in 2011 is estimated to be above the LRP, with a low probability of being below the LRP (0.08).

Further background information is available through documentation identified within the Sources of Information section.

Analysis and Responses

The Science response did not evaluate the ability of the CPRS to meet the management objectives, rather it determined if the CPRS could be quantitatively evaluated through simulation.

Quantitative Evaluation of the CPRS through Simulation

Is the proposed Conservation Plan and Rebuilding Strategy (CPRS) for 3Ps cod described in a form that would allow quantitative evaluation through simulation. If not, what modifications would be required to the CPRS?

The CPRS cannot be quantitatively evaluated in its present form.

If the plan is meant to serve as a guide to managers to provide a range of annual TAC options, rather than a prescriptive harvest control rule when the stock is in a particular condition, then it cannot be evaluated since the subjectivity of such a process cannot be quantitatively simulated.

Under the assumption that the plan is meant to specify the actual TAC value that managers would apply each year, then modifications could be made to allow it to be quantitatively evaluated.

The rules as they are currently written define a decision space from which the TAC could be chosen rather than prescribing a specific TAC that one would choose under particular conditions. Some examples (but not an exhaustive list) are given below.

- 5a iii) states that 'TAC decreases should not be less than 125% of the percentage decrease from the most recent 3 year average SSB.' This is not possible to evaluate since the TAC could be anywhere from 125% of the percentage decrease in the SSB to zero. If the rule were written as 'TAC decreases would be 125% of the percentage decrease from the most recent 3 year average SSB' then this could be tested.
- The sentence in 5a i) 'Decision-making should be guided by the recent SSB trajectory and also the expected trajectory relative to the recruitment index' is a guideline to managers and is not testable as it is not possible to predict what decision might be made under this scenario.
- The rules in 5b are confusing in that it is not clear that ii) and iii) apply to any TAC change rather than only to TAC change above 125%. In addition it is not clear that the last clause in ii refers to both the a) and b) conditions in this rule.

Quantitative Evaluation of the CPRS with SURBA

Is the existing stock assessment method (SURBA) for 3Ps cod is amenable to quantitative evaluation of the CPRS through simulation? If not, could SURBA be modified to allow such an evaluation or could suitable alternative approaches be developed and applied to carry out such an evaluation?

The SURBA model currently used to assess the 3Ps stock of Atlantic cod does not include fishery landings statistics. Therefore it cannot be used to evaluate the specific impacts of catch levels, and is not useful as a tool for quantitative evaluation of the CPRS through simulation.

There is uncertainty about the levels of landings for 3Ps cod. As such, the SURBA model, which does not incorporate landings, was proposed for the assessment of this stock. This model operates in relative terms and therefore provides no way to estimate actual biomass. Assessment models do exist that can be used when there is uncertainty in landings. However these would need to be developed for the 3Ps stock of Atlantic Cod and peer reviewed in an assessment framework process. These developments would not be possible in the near future (certainly not before the 2013/2014 fishing season) and require the investment of significant human resources and additional expertise.

CPRS management objectives

Where quantitative evaluation is feasible, are the desirable management objectives of the CPRS known and can they be transformed into measurable performance statistics for simulation testing?

The management objectives are 'To achieve and maintain the 3Ps Cod Spawning Stock Biomass (SSB) in the 'healthy zone' as defined by DFO's Precautionary Approach framework, and at or near Bmsy or its proxy, and to provide reasonable fishing opportunities during the rebuilding period'. These objectives have not been stated in a way that can be measured. Timelines to reach the 'safe zone' and Bmsy need to be identified and risk tolerances specified. Further in the proposed CPRS it states 'The fishing mortality rate should not exceed F_{max} '. It is assumed that this is meant to be F_{msy} . The time horizon and risk tolerance for evaluating $F > F_{msy}$ are also not identified. Finally, the meaning of 'reasonable fishing opportunities' would need to be presented within the objectives in a quantitative manner. Until these aspects are specified it is neither possible to test if any CPRS would meet the management objectives nor to determine if objectives are actually being met should the plan be implemented.

Conclusion

The CPRS, in its present form, is unable to be quantitatively evaluated. However, modifications may be possible that would allow such an evaluation, where wording is prescriptive of decisions to be made under particular conditions. The present (SURBA) assessment model cannot be used in a quantitative evaluation of a CPRS which makes decisions regarding TAC given that it is unable to evaluate the specific impacts of catch levels. Other assessment models exist that can be used when there is uncertainty in landings, but these would need to be developed for the 3Ps stock of Atlantic Cod and peer reviewed in an assessment framework process. Notably, these developments are not possible in the near future (and not before the 2013/2014 fishing season) and require the investment of significant human resources and require additional expertise. Finally, regarding the management objectives of the CPRS – these are also unable to be quantitatively evaluated as currently stated.

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Sources of information

Cadigan, N. 2010. Trends in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Cod (*Gadus morhua*) stock size based on a separable total mortality model and the Fisheries and Oceans Canada Research Vessel survey index. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/015. iv + 43 p.

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Appendix

3Ps Cod Conservation Plan and Rebuilding Strategy April 2012 - March 2016 (012712 Draft)

1. Preamble:

International agreements such as the United Nations Fish Stocks Agreement (UNFSA) and the FAO Code of Conduct for Responsible Fisheries, and DFO's Precautionary Approach Framework call for the rebuilding of depleted stocks through application of the precautionary approach. Continued rebuilding and growth of this stock is desired, to ensure its long-term sustainability and to promote associated economic opportunities.

In future, it may be possible to calculate MSY-based reference points for this stock through additional study of the current assessment framework or application of alternative assessment methods. The current assessment model accepted for this stock is SURBA, a cohort-based model that uses age-by-age data from the research vessel survey.

For 3Ps Cod, the limit reference point has been identified as Brecovery, which is the lowest level of spawner biomass (in 1994) from which recovery was observed to have occurred. Other reference points have been developed from this, to serve as decision points for the harvest control rules. Available data do not span the entire production curve, and uncertainty in the estimated reference points can be expected. Also, changes in population biology and fishing practices can have a large impact on the estimated level of some reference points.

This cod stock supported a fishery with annual landings ranging from 27,000t (1978) to 86,000t (1961), and averaging in excess of 50,000t for the period 1960 to 1990. Data indicates the total mortality rate has been increasing steadily above the mean since 2004, if this continues there will be an impact on rebuilding efforts. Rebuilt stocks may also differ markedly from their status prior to depletion.

Experience gained from the application of this plan will be reviewed in 2016 to determine the extent to which changes in the plan might be made. Adjustments to the plan could occur earlier if important new information becomes available or if there is a change in stock assessment methodology.

2. Objective:

To achieve and maintain the 3Ps Cod Spawning Stock Biomass (SSB) in the 'healthy zone' as defined by DFO's Precautionary Approach framework, and at or near Bmsy or its proxy, and to provide reasonable fishing opportunities during the rebuilding period.

3. Reference Points for Spawning Stock Biomass (as represented by SURBA relative index):

- a) Establishment of a Bmsy proxy is subject to further development
- b) Upper stock reference (USR) = $2 \times \text{Blim}$
- c) Limit reference point = Brecovery (1994 SURBA index)

4. Interim Milestones/Constraints:

- a) To cap Total Allowable Catch (TAC) at the 2011-12 level until the 3-year average SSB reaches 125% of Blim; it is expected that this level may be reached by 2014.
- b) To set a lower rate for TAC increases, and a higher rate for TAC decreases, than the rate of change occurring in the SSB index, until the SSB reaches the USR (200% of Blim)

5. Harvest Control Rules:**a. When the SSB is in the Critical Zone (below Blim):**

- i. Directed fishing may be permitted if the 3-year average SSB is below Blim, but should not be permitted if the 3-year average SSB declines below 75% of Blim. Decision-making should be guided by the recent SSB trajectory and also the expected trajectory relative to the recruitment index.
- ii. No increase in the TAC will be considered until the 3-year average SSB has increased above Blim.
- iii. TAC decreases should not be less than 125% of the percentage decrease from the most recent 3-year average SSB.

b. When the SSB is in the Cautious Zone (between Blim and Busr):

- i. No increase in the TAC will be considered above the 2011-12 level of 11,500t until the SSB is at least 125% of Blim and the recruitment index is at least 75% of the mean of the time series.
- ii. TAC increases should not exceed the lesser of (a) 85% of the percentage increase from the most recent 3-year average SSB, and (b) 15%, unless the recruitment index is less than 75% of the mean of the time series, in which case the increase would be reduced by 1/2 of what it otherwise would have been.
- iii. TAC decreases should not be less than 115% of the percentage decrease from the most recent 3-year average SSB, unless the recruitment index is at least 125% of the mean of the time series, in which case the decrease would be reduced by 1/2 of what it otherwise would have been.

c. When the SSB is in the Healthy Zone (above Busr):

- i. When the SSB is above the USR, TAC increases or decreases should not exceed the lesser of (a) the percentage increase from the most recent 3-year average SSB, and (b) 15%.

Notes:

- Percent change in the 3-year average SSB is calculated as $((Y-X)/X) \times 100$ where Y is the mean of relative SSB from SURBA in years n+1, n+2, n+3, and X is the mean of relative SSB from SURBA in years n, n+1, n+2.
- The recruitment index is calculated as the mean of SURBA age 1 values in years n-5, n-4 and n-3. It is an index of recruitment at ages 4-6 in year n, the year for which the TAC is being calculated.
- The fishing mortality rate should not exceed Fmax; this limit reference point cannot be calculated at this time.

Attachments:

- SURBA index for spawning stock biomass
- 3-year running average SSB
- Recruitment index
- Catch history

Year	SSB/Blim (SURBA)	3 yr running average	% change recruitment in 3yr avg	recruitment Age 1 SURBA	rec. index 3 pt avg	Catch
1983	1.43			10.79		38451
1984	1.47			5.48		36950
1985	1.64	1.51		6.61	7.62	51367
1986	1.60	1.57	3.78	8.06	6.72	57990
1987	1.55	1.59	1.65	9.73	8.13	59204
1988	1.66	1.60	0.51	11.27	9.69	43382
1989	1.89	1.70	6.16	7.23	9.41	39540
1990	1.78	1.78	4.49	17.90	12.13	41405
1991	1.46	1.71	-3.67	7.98	11.03	43589
1992	1.25	1.50	-12.58	2.66	9.51	35895
1993	1.02	1.24	-16.79	4.02	4.89	15216
1994	1.00	1.09	-12.43	4.10	3.59	661
1995	1.42	1.15	5.18	4.37	4.16	821
1996	1.46	1.29	12.70	4.46	4.31	1057
1997	1.18	1.35	4.69	4.05	4.29	9420
1998	1.30	1.31	-2.81	9.10	5.87	20156
1999	1.49	1.32	0.73	8.98	7.38	27997
2000	1.58	1.46	10.10	4.46	7.51	25100
2001	1.64	1.57	7.77	3.55	5.66	16546
2002	1.89	1.70	8.52	4.62	4.21	15319
2003	2.25	1.93	13.07	4.70	4.29	15260
2004	2.29	2.14	11.20	5.01	4.77	14414
2005	1.92	2.15	0.49	8.00	5.90	14776
2006	1.51	1.91	-11.53	8.25	7.09	13157
2007	1.23	1.55	-18.55	15.98	10.74	12959
2008	0.96	1.23	-20.70	6.11	10.12	11773
2009	0.89	1.02	-16.80	9.06	10.39	9762
2010	1.05	0.96	-5.91	7.61	7.60	8334
2011	1.34	1.09	13.29	1.30	5.99	4248

avg = 7.08

Recruitment index for year n in table applies to year n+3 for TAC calculation

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